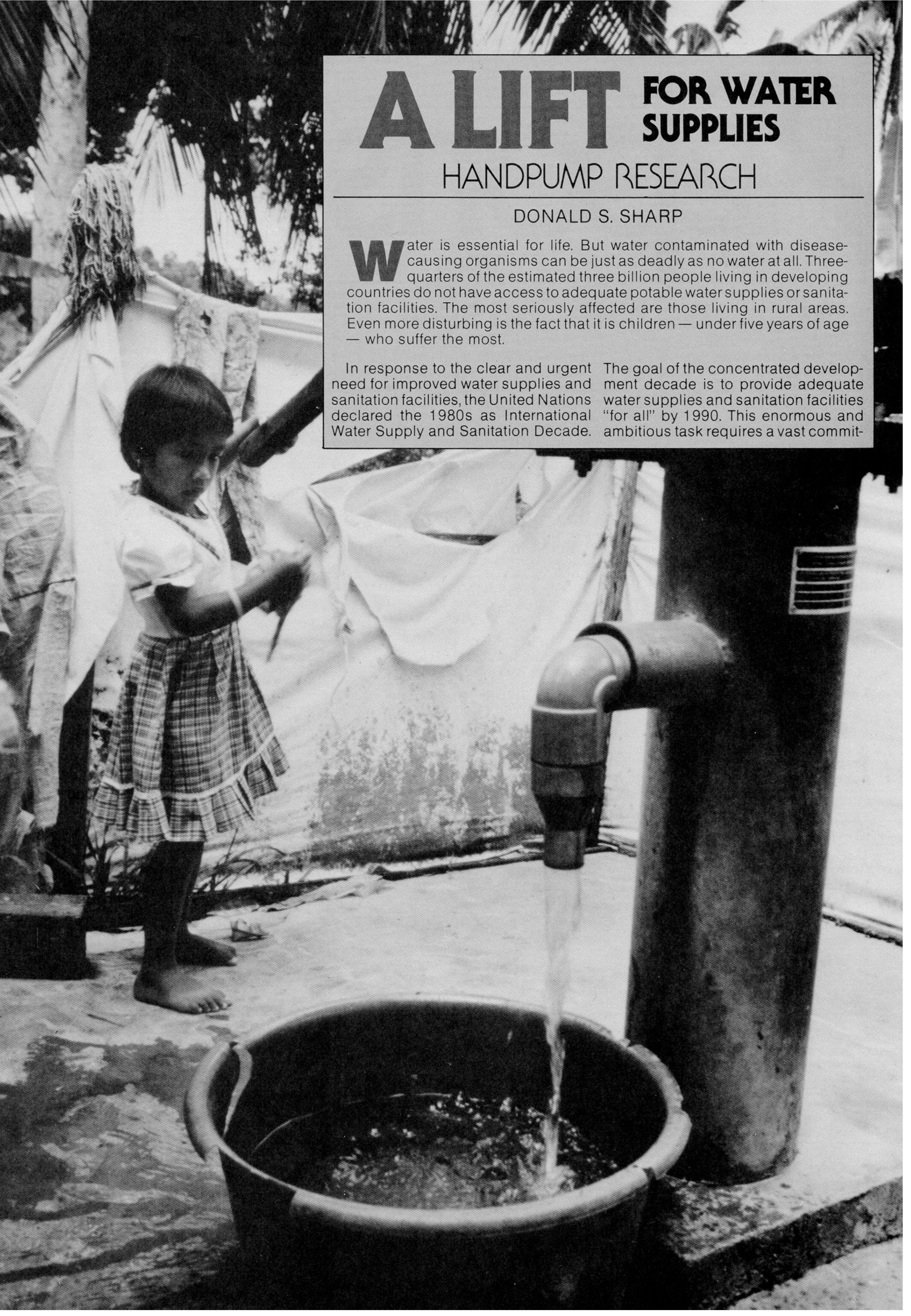
A LIFT FOR WATER SUPPLIES

HANDPUMP RESEARCH

DONALD S. SHARP

Water is essential for life. But water contaminated with disease-causing organisms can be just as deadly as no water at all. Three-quarters of the estimated three billion people living in developing countries do not have access to adequate potable water supplies or sanitation facilities. The most seriously affected are those living in rural areas. Even more disturbing is the fact that it is children — under five years of age — who suffer the most.

In response to the clear and urgent need for improved water supplies and sanitation facilities, the United Nations declared the 1980s as International Water Supply and Sanitation Decade. The goal of the concentrated development decade is to provide adequate water supplies and sanitation facilities "for all" by 1990. This enormous and ambitious task requires a vast commit-



ment of resources. Providing clean water requires political will, technical expertise, financial and material resources, all supported in a management structure capable of realizing plans as programs of action.

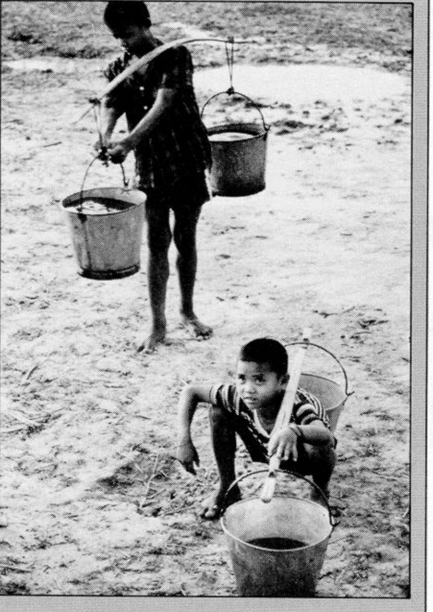
In areas where groundwater is readily available, the handpump is the simplest and least costly method of supplying safe drinking water. By the year 1990, some 1833 million (1.8 billion) people in the Third World (excluding China) will require new, clean water supplies. Almost 1400 million (1.4 billion) of those will be living in rural areas. To provide water supply services for many of these people, approximately 20 million or more handpumps may be needed by the year 2000. Replacement pumps will be needed for at least 500 million people during this same period, adding another 2.5 million pumps to the total requirement.

The development of reliable handpumps that can be locally produced, installed and maintained at a reasonable price would be a major step toward providing reliable, safe drinking water supplies to those who need it most — the rural communities. Due to technical, social, and economic reasons, rural people in the developing world will be dependent on manual pumps for many years to come, not only for drinking water but also for water for other domestic uses, livestock, and small-scale irrigation.

The cost of a handpump varies from a low of about US$20 (CA$26), for a simple shallow-well pump, to a high of around US$2000 (CA$2600), for a heavy-duty, deep-well pump. The average cost per handpump is about US$150 (CA$195). The World Bank reports that in one East African country, where the government is committed to developing rural water supplies, the average maintenance cost per pump per year is approximately US$400 (CA$525). The International Reference Centre for Community Water Supply and Sanitation put the minimum cost to bring safe water and adequate sanitation to all by 1990 at an estimated US$300 billion (CA$390 billion) — even using low-cost technologies and community self-help. It is clear that governments and aid agencies alone will not be able to support the bill.

If any significant headway is to be made, it must be achieved through the efforts of the rural people themselves. This means that serious thought must be given to developing pumping devices that can withstand the use — and abuse — of large user groups. It means pumps that can be purchased, installed, and maintained locally. Even more important, it means pumps must be manufactured in-country using available materials, thus reducing reliance on imports. Governments must develop strategies to promote community acceptance and self-reliance at the village level. Programs for the effective transfer of the technology to the villagers themselves must be developed and implemented.

One of the most important problems in rural water supply programs is the high failure rate of conventional manual pumps. Failures occur mainly because pumps were not designed for the level of stress and abuse they routinely receive in the rural areas of developing countries. Because the materials from which conventional pumps are made — mainly cast-iron and steel — are not only expensive, but are not readily available locally, many developing countries must rely on imported pumps and parts supplied by international and bilateral donors. This presents difficulties in terms of costs, and maintenance requirements, and problems in procurement of spare parts.



(Opposite) A simple, village-level operated and maintained water pump — such as this one in Malaysia — can bring safe water within the reach of many rural people. (Above) A long trek for a few buckets of muddy water from an unprotected well in northeast Thailand: for many, disease comes with the water

Since 1976, IDRC has been supporting research on the development of more effective pumping systems for rural water supplies. The approach taken has been to examine systematically the implications of new materials and improved pump designs. In view of the widespread introduction of plastics technology that has taken place in developing countries in the last decade, particular attention was focused on the polymer resins, specifically polyvinylchloride (PVC) and polyethylene (PE). Both materials are widely available throughout Africa and Asia. In many respects, plastics technology is to developing countries what cast-iron was to industrialized countries many years ago. The vast potential of plastics for use in handpump components has only recently been explored.

The IDRC-sponsored design work centered on developing a simple, low-cost PVC piston and foot valve assembly for a manual, shallow-well pump. These below-ground components — the piston and foot valve — were designed to be interchangeable, thus saving labour costs in manufacture, simplifying maintenance procedures, and keeping the required number of parts to a minimum.

Early development research was carried out by a Canadian University, the University of Waterloo, and was completed in April 1978. The prototype pump assembly was then tested at the Consumer's Association Testing Facility in England as part of a project sponsored by Britain's Overseas Development Ministry. The tests established the reliability and efficiency of the Waterloo design compared with the technology of the time. The Waterloo pump differed from others in the testing program in that it was designed specifically for manufacture in developing countries, utilizing existing, locally available resources.

The next stage, later in 1978, was to support research groups in several African and Asian countries to field-test the pump. Trials were undertaken in Malaysia, the Philippines, Sri Lanka, and Thailand in Asia, and Ethiopia and Malawi in Africa. The primary objectives of these research projects were to assess the Waterloo design in varying environmental conditions. The research was to determine the appropriateness of the pump for local manufacture and to estimate the cost of manufacture. Further, the research was to evaluate reliability and durability, maintenance requirements at the village level, and technical performance of the pump. IDRC's approach was to provide the researchers with a prototype, which the research team would reproduce and field test. As it turned out, the design was modified according to the availability of local materials and the results of further in-country laboratory tests. The above-ground components — spigots and pumpstands — were individually designed and locally produced. These modifications turned out to be an advantage, as they proved that a technology must first be adapted to local conditions before it can be successfully adopted.

In August 1980, a mid-project meeting for the four Asian projects was held at the University of Malaya, Kuala Lumpur, to review their progress and establish common field monitoring and measurement techniques. A unique method for accurately determining pump usage by means of a mechanical counting device, designed at the University of Malaya, was incorporated into the field testing program. This device made it possible to correlate measurements of wear with the distance the piston traveled, or the amount the pump was used, and made accurate field monitoring possible. This IDRC-sponsored field testing program is believed to be the first of its kind.

The second round of IDRC-supported research includes projects in Malaysia, Sri Lanka, Thailand, Philippines, Ethiopia, Indonesia (under negotiation) and Costa Rica (under negotiation). Two research groups in India have also expressed interest in the PVC pumps. These new projects will examine ways of promoting community acceptance, financing and maintenance schemes, and various community-based manufacturing options. In addition, low-cost well-drilling techniques will be investigated. In conjunction with this network of projects, a special project on support materials for handpump installation and maintenance (a manual designed for illiterate and semiliterate villagers) is being developed.

As many international, national and private institutions and agencies (including IDRC) have embarked upon research and development programs to improve handpump designs, there is now an urgent need to assess the present knowledge, situation and trends in regard to handpump technology, and review and document the changes that have taken place.

The IDRC approach has been to encourage local researchers to experiment with a basic design and adapt it to local conditions with the materials available to them. In this way we hope to promote the development of a true village-level operated and maintained (VLOM) pump. Rather than focusing on heavy-duty, medium and deep-well designs and large-scale centralized commercial production, our program has emphasized simplicity, low-cost and small-scale, decentralized manufacture. In addition, in keeping with the IDRC mandate, we are attempting to develop local expertise in all aspects of handpump technology, from experimentation to manufacture.

It must be remembered, however, that transfering a technology is not a simple case of financial resources, trained experts and a good design. It also involves complex social, cultural, political, and economic considerations that are best — perhaps only — understood by the people themselves. Technology cannot be "parachuted in." It must be examined, tested, and modified according to local needs, available expertise and materials.

Finally, it must be pointed out that the basic Waterloo design is no better or worse than any other design. It is one of many technical options. In some communities, a pump with PVC components may be the answer, in others it may only serve as an interim technology until something better can be afforded. In still other communities, it may not be suitable at all. However, for the many millions of the world's rural population, PVC handpump technology is a beginning, a contribution to the Decade target of clean water for all by 1990. □

Donald S. Sharp is associate director, water supply and sanitation, of the Health Sciences Division of IDRC.

A QUICK FIX

Somewhat more than a million people in the Central Highlands of Malawi get their water from unprotected waterholes near lowlying dambos, where surface water collects from rain runoff. Cholera has been a severe problem, prompting Malawian health officials to give a high priority to protecting water supplies from contamination. An IDRC project testing the PVC handpump was part of the program.

Tom Nkana, project manager for the community protected wells program, stands in front of a large topographic wall map of the highlands tacked up at the program's workshop headquarters in Dowa. He points to the carefully drafted circles that mark off about 16 different regions, their radius the distance a technical assistant can cover by bicycle in a day. Some circles are studded with coloured pins representing, Mr Nkana explains, well sites at various stages of development. The villagers make 1000 bricks, dig and lay the foundation for a well with supplies and direction from the program. The program installs a concrete slab top and pump, and trains a member of a village-appointed well committee in operation and maintenance.

One pins marks Mayiloni, a family settlement in the Nambuma area that has had a well for about a year. Mayiloni at first appears to be not much more than the well, the centre of a latticework of paths weaving off into the low surrounding brush. But within ten minutes of the arrival of Mr Nkana and IDRC researcher Lindsey Robertson of the Ministry of Community Development and Social Welfare on an inspection tour, a small crowd has gathered. One member of the village well committee, armed with a project-provided spanner and a large pipe wrench, quickly unfastens the pump-stand with a few practiced turns and eager hands pull the pump up for a look.

Malawi has been testing and developing pumps for its wells program for a number of years; this pump is something of a mutant, combining the cast-iron pumpstand, pump rod, and couplings of earlier versions with the PVC piston, valves, and casing of the latest designs. The piston and rings are still in good shape, although some scratching is apparent.

Robertson gives the sealing rings an experimental prod, checking for spring. "They seem to be holding up rather well," he says. "We were expecting that the rings would lose elasticity — at least that was the laboratory finding. Actually, the rings don't seem to significantly improve efficiency. The interesting thing is that they take all the wear and can easily be replaced. And sand and foreign material just becomes embedded in the softer rings instead of wearing against the pipe wall.

"It's quite a different thing to test a pump in Waterloo, Canada, and to use it every day here in Malawi. One of our problems has been with hyenas chewing the tee fittings and spigots from our pumps. The white PVC we use looks like bone — a favourite with them. You can't really plan for that."

What happens next seems to make his point even more convincing. The pump is checked and put back in place, and the well committee man fills a bucket to be sure everything is in working order. The visitors are invited to pump a few courtesy strokes. When Robertson steps up to the pump, the water stops. Something has gone wrong. The committee man steps in with his helpers and unbolts the pump-stand again. The pump comes off the well, but this time no pipe is attached. The threads on the metal coupling joining the PVC casing to the pump have rusted out and been stripped. The casing separated and fell into the well.

A boy is sent running for some string, which is wrapped around the threads to pack the joint and make it secure. A few minutes later, water gushes once again from the spigot. The repair is temporary, but sufficient. The Mayiloni well is scheduled to receive an all-PVC pump within the near future.

It is obvious that the villagers take great pride in their well and in their ability to maintain it. The pump has not betrayed the effort they invested in building the well and learning new ways of using water. They can trust it to work, and if something should go wrong, it is not too difficult to set right again quickly.

The PVC pump has caught on in Malawi. The project headquarters had to be moved because enthusiastic adoption in the original area quickly "saturated" it with close to 100 installations. The Malawians have 500 experimental pumps. They are waiting for the research results to be incorporated into a final set of specifications, and then plan to manufacture and install the best version in the thousands.